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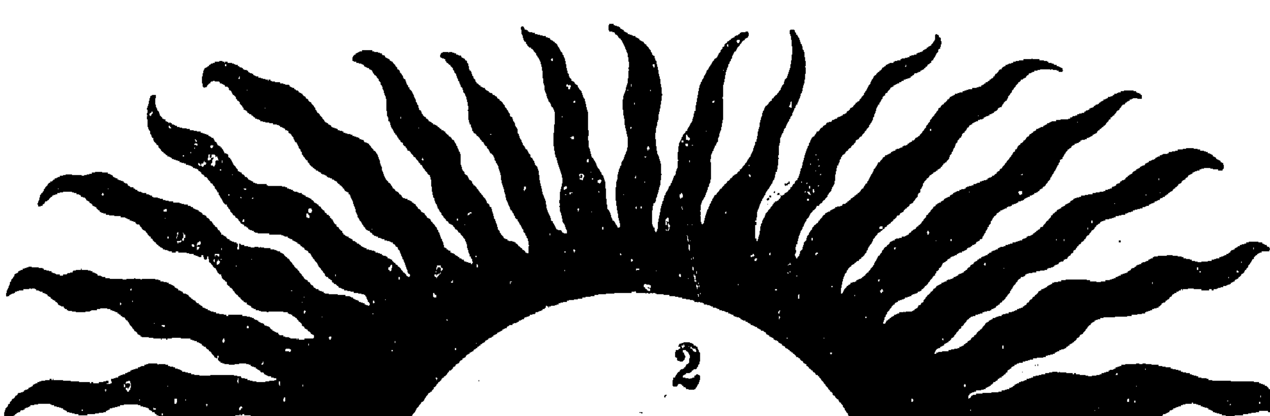
ABSTRACT

Four articles about future energy technologies and problems comprise this collection of readings intended for the junior high school language arts curriculum. Each entry has been scored for readability according to the Gunning Fog Index. By referring to these ratings, a teacher can provide students with increasingly more challenging reading material. A glossary of energy terms and a list of related readings follows the articles. This book is the last in a series of four volumes on energy. (WB)

May 1980
U.S. Department of Energy

BOOK IV
EASY ENERGY READER

ENERGY: WHAT ABOUT THE FUTURE?



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BOOK IV
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Prepared by
Information Planning Associates, Inc.
Under Contract No. EU-78-C-01-6497
for
The Department of Energy
Office of Consumer Affairs
The Education Programs Division
Washington, D.C. 20585

BOOK 4

ENERGY: WHAT ABOUT THE FUTURE?

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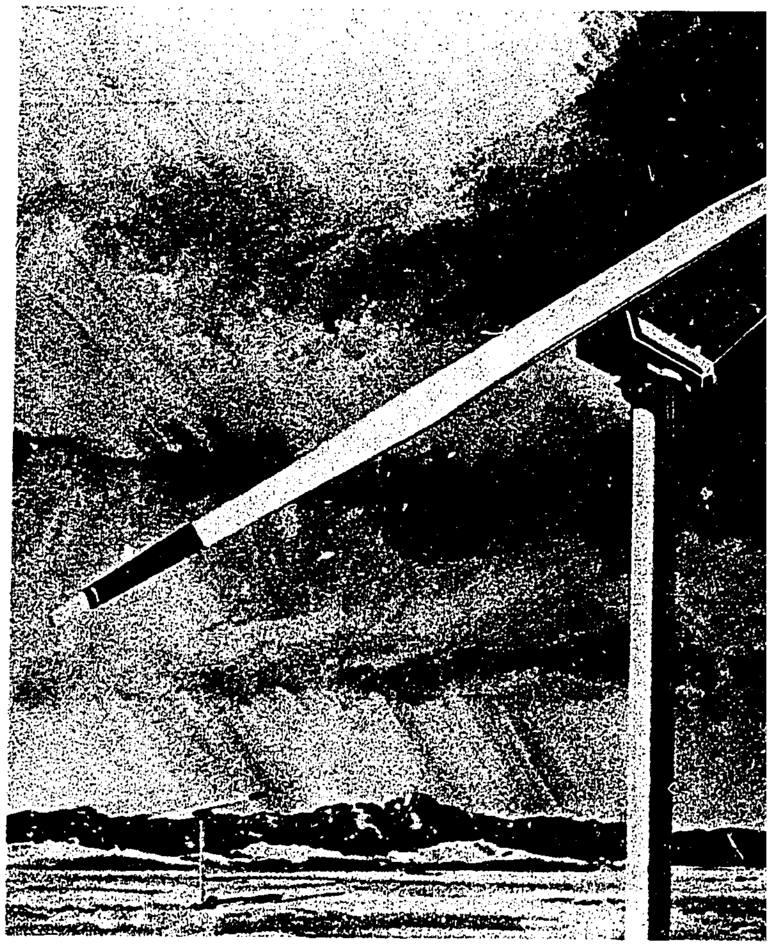

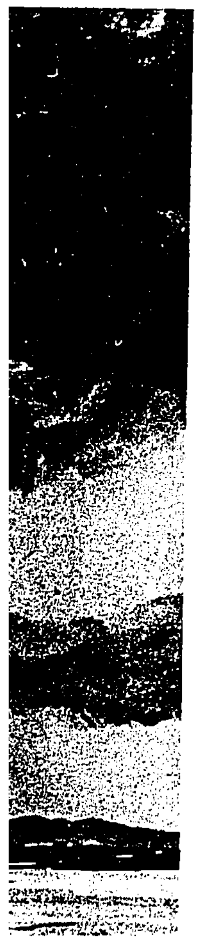

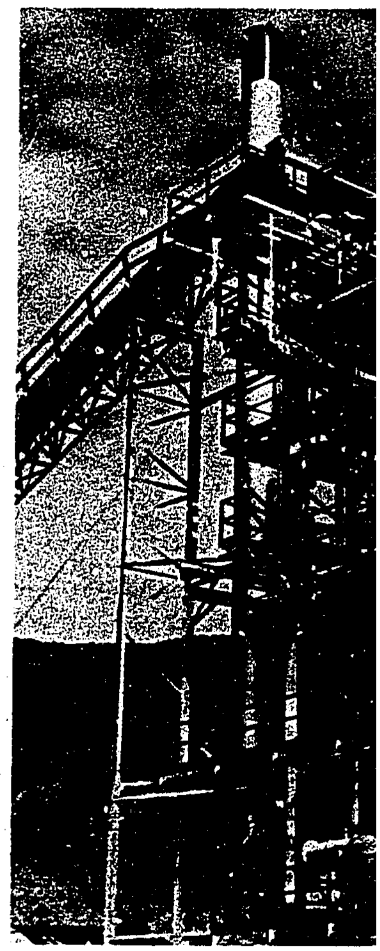

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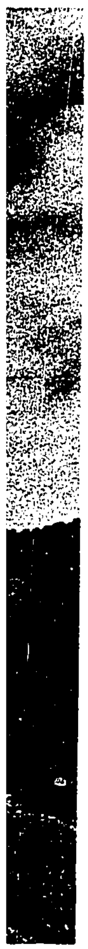

PREFACE
TO THE INSTRUCTOR

As current issues have come to play a greater role in the language arts curriculum, the need for up-to-date materials on the technical and social foundations of these issues has increased. This has been a particular problem for the instructor of junior-high and middle school students, who may find that debate manuals and source books do not adequately consider the reading skills of the younger reader. Nowhere is this more evident than in the area of energy. The *Easy Energy Reader* has therefore been developed to help fill this information gap as well as to direct instructors and students toward other useful materials.

To facilitate reading, the *Reader* has been divided into four volumes. Book 1 discusses what energy is, where it comes from, how it is stored, and how it is transported; Book 2 talks about the history of energy and how it has come to play such an important role in our daily lives; Book 3 analyzes the causes of the nation's current energy-related problems and offers possible solutions; and Book 4 provides an insightful look at future energy technologies.

The readings in these books were selected on the basis of their currency, their importance to the student's understanding of energy issues, and their readability. The articles chosen provide a wide range of readability levels, which will accommodate the wide range of abilities found in middle school and junior high classrooms.

The Gunning Fog Index, with slight modifications, proved to be the most useful in scoring entries for the *Reader*. We elected to apply the index to a 300 word sample rather than the 100 word sample cited in the instructions to ensure the accuracy of the results. Also, certain three-or-more syllable words were not counted, as the formula suggests, because of their frequent recurrence and the obvious ease of the word, such as energy, conservation, etc. On occasion, it was necessary for the researcher to use his discretion in adding a point or subtracting a point because of the importance average sentence length plays. If it was noticed that sentences in certain articles were rather short but the text complicated, a point was added in most cases. Whereas if the reverse was true, i.e., long sentences but uncomplicated text, a point was then subtracted, thus producing a more accurate readability level for that article.

The formula that we used works as follows[1]:

1. Select a sample of 300 words.
2. Find the average sentence length.
3. Count the number of words of three syllables or over. (Do not count proper nouns, easy compound words like "bookkeeper," recurring familiar words such

[1] Editor's Note: Adapted from *Toward World Literacy*, by Frank C. Laubach and Robert S. Laubach, Copyright © 1960, Syracuse University Press.

as "automobile" or "energy," or verb forms in which the third syllable is merely the ending, as, for example, "directed.") Divide by 3.

4. Add average sentence length to the number of "hard (three-or-more syllable) words."
5. Multiply the sum by .4 (four-tenths). This gives the Fog Index.

The equation for steps 4 and 5 is:

Number of "hard words"	+	Average number of words per sentence	×	.4 = The Fog Index

The table below lists in increasing order of difficulty the articles that are included in Book 4, *Energy: What About The Future?*

TITLE	FOG INDEX*
Energy From the Sea	9.0
The Nightmare Life Without Energy	9.0
Future Energy Sources— The Promise and the Problems	9.0
It's Up To Us	9.0

By providing an array of readings in the four books of this series, we hope to make the *Reader* more useful to the teacher who wishes to individualize instruction or to develop a curriculum of increasingly more challenging reading. Students can be encouraged to increase their energy vocabularies by studying the glossary at the back of each book.

Many of the readings lend themselves to problems in distinguishing between fact and opinion, and may be useful as background for mini-debates. Role-playing activities in which students represent the positions of consumer, environmentalist, or electrical utility executive could also be drawn from most of the articles, or current newspaper editorials might be analyzed according to whether the *Reader's* authors would agree or disagree. Students might also be encouraged to write their own letters to the editor in reply.

Simulated news broadcasts and interviews could be prepared using this material, or the readings could be used as preparations for interviewing people from the community, such as representatives of the solar equipment industry, utilities, alternate energy activists and school personnel responsible for reducing energy use.

There are of course many other uses for the *Reader*, both as part of the regular curriculum and as a resource for independent study. For example, it provides a number of good models of technical writing, a skill which is usually not taught until the student's senior year or college, if then.

*F [illegible] to nearest .5

Yet educators have observed that the best time (the 'teachable moment') to help students communicate about a subject is while they are discovering their interest in it rather than after they have become immersed in its jargon and shorthand. We hope the *Reader* can help achieve that objective. We would appreciate your ideas and comments and those of your students. Please address them to:

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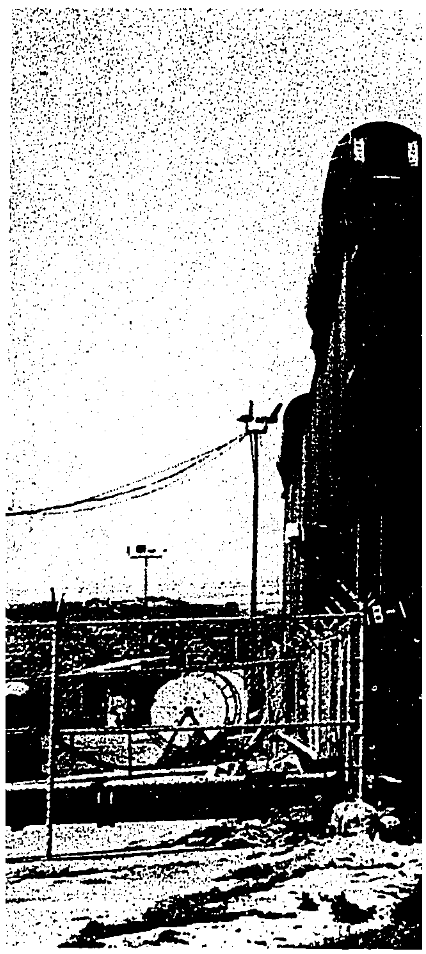
U.S. Department of Energy
Washington, D.C. 20585



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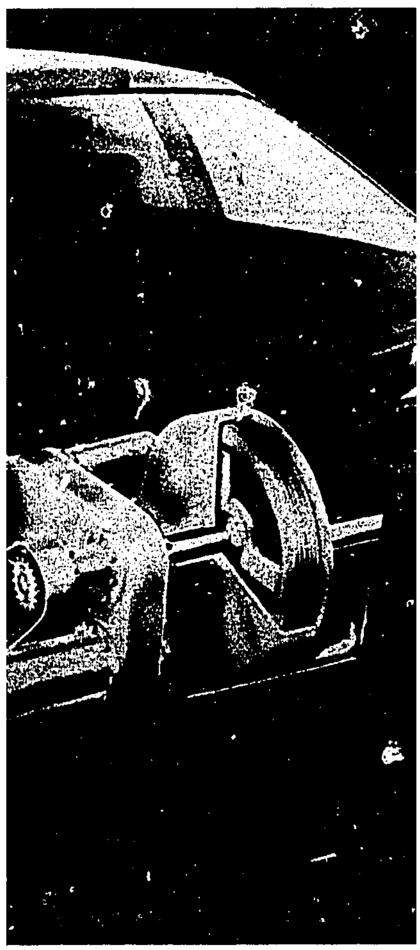

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INTRODUCTION

Just Imagine

Imagine that it is night, and everything around you that runs on electricity has stopped forever. The lights. The heating and air conditioning. The television and radio. The refrigerator. Street lights and stop lights and clothes washers and driers, stoves and toasters and hair driers and stereos. What else has stopped? Could you pick up the phone to call someone and find out why everything that uses electricity has stopped?

How would you see? How would you stay warm in winter and cool in summer? How would you send messages and be entertained at home? How would you wash and dry your clothes and cook your food?

You would look for other ways to do these things; you would look for other kinds and sources of energy. You might find that you could get along just fine without many machines. Just because your electric toothbrush wouldn't buzz any more would not mean you had to stop brushing your teeth. And you might discover that you could do without a clothes dryer by letting the sun do the drying.

Try to think of other ways to replace electricity in your daily life.

It Wouldn't Be The First Time

Just about everyone knows that there was a time when we had no electric heat for our homes. It simply didn't exist. Yet people stayed dry and warm by burning oil. Many homes are still heated that way.

What about the days *before* oil? We burned coal. Many homes in the world still do. A lot of factories do, too. And coal, like oil and gas, is now burned to make electricity. And how did we keep warm before coal? We burned wood.

In fact, all through history we have found ways to keep ourselves warm and dry and to cook our food and to make enough light to see by. We have used many, many sources of energy.

This Book Is About Energy

This book is about the energy that runs machines and lights and furnaces and electric blankets and automobiles. It is about how we get energy from many sources, and what we can do when one source or several sources begin to run out. This book will help you understand why it is important not to waste energy, as well as point out some of the things we can do to save it. It will help you think about what *you* want to do to help make sure there will always be plenty of energy for all of us.

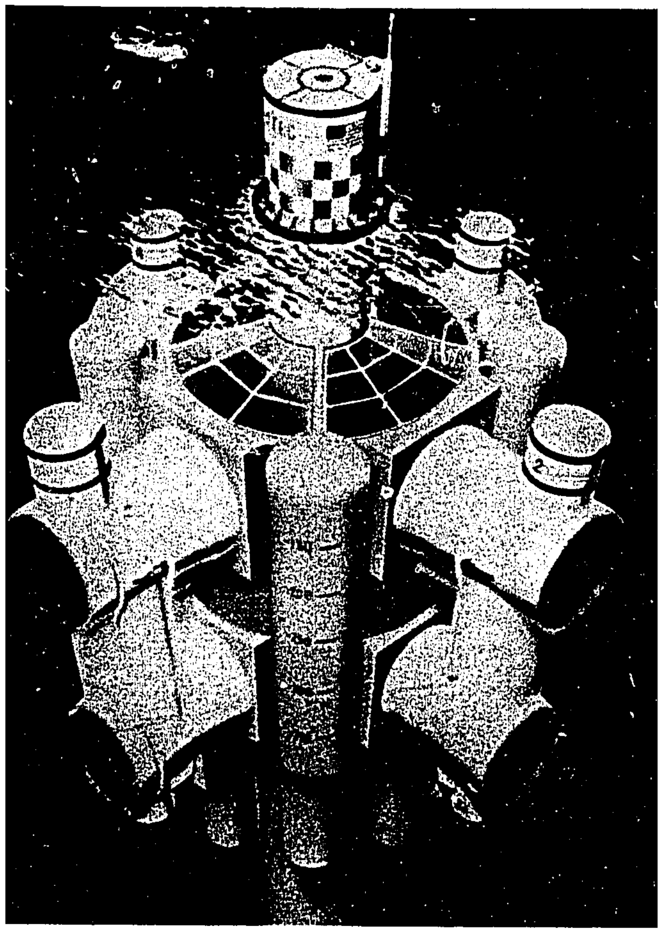
This Book Has Many Authors

The chapters of this book come from many different books and magazines. Each chapter is

about a different part of the subject of energy: what it is, where it comes from, why some kinds are becoming very expensive, how different people feel about it, and many other topics. Remember, these are not official opinions of the United States Department of Energy. Instead, the chapters will give you an idea of what many different people are saying about energy. You will see that people disagree about how to make sure there will always be enough energy. But everyone agrees that each of us will have to make important choices about energy. That is why we hope you will find this book useful.

This Book Can Be Used In Many Ways

This book can help you learn to read about energy. Some chapters are harder than others, and your teacher can suggest the chapters to start with and the ones to read next. (There is also a list of energy words at the end of this book to help you build your vocabulary.) When you find a chapter you especially like, you may want to read the book from which it came. The first page of each chapter will tell you its source. Then look in the list of suggested reading for information that will help you find the original book or magazine. If it is not in your school library, your librarian may be able to help you get it from another library. Another way to use this book is to close it up every so often and look around you at what energy does. Think about which uses of energy are really necessary and which are not. Think about what you would be willing to give up for a gallon of gasoline or the comfort of an air-conditioned building. Then, when you are finished with this book, pass it on to a friend. By putting our energies together, we can help to assure a bright energy future for everyone.



'ng platforms that float beneath the ocean surface are
· the sun's energy stored in the sea.

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ENERGY FROM THE SEA

By Don Kirkman

WASHINGTON — (ESN) -- The oceans have always helped man. They give us food. They supply us with minerals and medicines.

Our oceans could also provide us with new energy sources. Some scientists believe that we can generate electricity from ocean currents. They also think that a seaweed called kelp may be a valuable source of fuels.

Kelp is a tough, flat seaweed. Along the Atlantic coast, it grows up to 20 feet long. In the Pacific Ocean, it grows much longer.

Kelp grows naturally in the shallow waters near the shore. It grows best in warm, sunny climates. This giant seaweed has no roots. Instead, it has string-like fibers which anchor the plant to rocks.

Kelp looks like a long, brown ribbon. Because parts of it are hollow, it floats straight up from its rocky bed. It collects the minerals and chemicals it needs for growth from the water.

The National Science Foundation (NSF) will soon begin a study of fuel production from kelp. Dr. Richard H. Bogan of the NSF says that we already know how to change kelp into oil, gasoline, and cooking and heating gas. The big problem, says Bogan, is getting enough of the seaweed.

One way to solve this problem might be to farm kelp.

Right now, U.S. Navy scientists are experimenting with a floating kelp farm off the California coast. On this farm, the kelp is grown on underwater nets.

At the same time, the NSF is developing better ways of changing kelp into fuel. It is using a process like the one used in making beer.

The kelp is ground up and mixed with water. Then it is treated with special chemicals. These chemicals cause the kelp to break down into simpler chemicals. Some of these simpler chemicals are useful as fuel.

The NSF expects to farm kelp in deep ocean waters within the next five years. Huge nets will probably be set out near the equator. Each farm would cover 10 square miles of ocean.

Bogan says kelp would be harvested by ships. It would be treated on board the same ships.

Kelp isn't the only source of energy in the ocean, say NSF scientists. Another source is the difference in temperature between warm and cold waters.

Our oceans contain many currents. Currents are like rivers which flow through the sea. These currents are made up of water that is warmer or

[1] Editor's Note: "Energy From the Sea", has been reprinted in part. Selection originally appeared with the following sections: New Words; New Words in Review; and Critical Discussion Questions.

colder than the waters around them. Interestingly, these waters rarely mix.

The NSF's Dr. Robert Cohen says that a power plant which used water temperature differences operated off the coast of Cuba in the 1920's. Cohen believes that the same process could be used to make electricity for the United States.

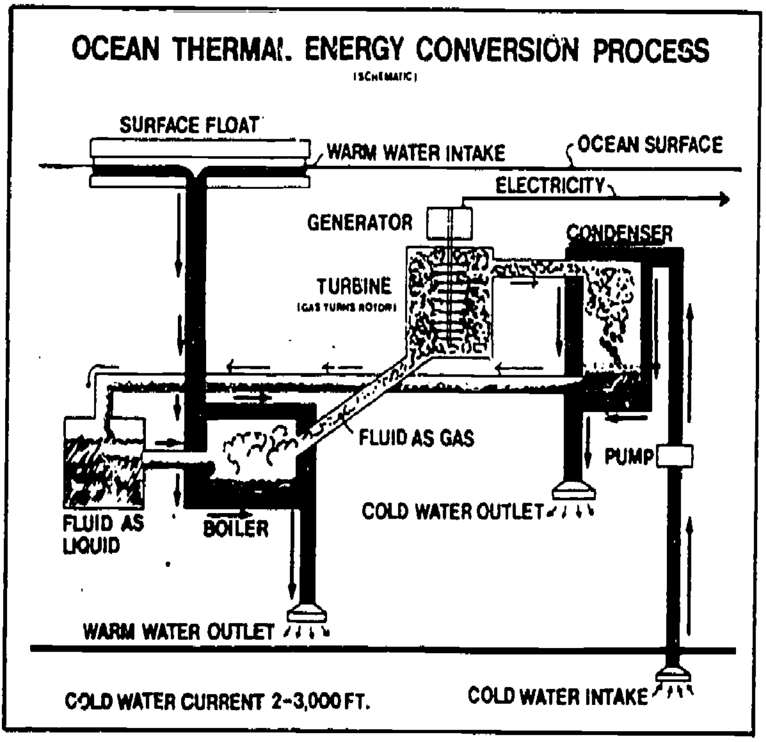

Figure 1. Creating Energy from Changes in Ocean Water Temperatures

In a floating power plant, warm water from one current would heat a liquid that vaporizes easily. The vapor would drive a turbine and generate electricity.

Cold water would be brought up from a deeper, lower ocean current. The water would cool the vapor after it had been through a turbine. The cooling would turn the vapor back into a liquid.

The process would continue over and over again. As long as ocean currents flowed warm and cool, electricity could be generated.

Cohen says that Florida's east coast would be a perfect place to build an ocean power plant. Here, the warm Gulf Stream flows on top of the cold Labrador Current. A floating power plant would have to hang down 2,000 feet to 3,000 feet to reach the cold layer of water.

NSF officials believe that someday these two ocean currents could solve some of our energy problems. However, a small test plant must be built first. NSF officials say that this test plant should be completed within five years.

Outdoor advertisements of the above type encourage the public to conserve gasoline.

THE NIGHTMARE LIFE WITHOUT FUEL

By Dr. Isaac Asimov

Americans are so used to limitless energy supplies that they can hardly imagine what life might be like when the fuel really starts to run out. So *Time* asked Science Writer Isaac Asimov for his vision of an energy-poor society that might exist at the end of the 20th century. The following portrait, Asimov noted, "need not prove to be accurate. It is a picture of the worst, of waste continuing, of oil running out, of nothing in its place, of world population continuing to rise. But then, that could happen, couldn't it?"

So it's 1997, and it's raining, and you'll have to walk to work again. The subways are crowded, and any given train breaks down one morning out of five. The buses are gone, and on a day like today the bicycles slosh and slide. Besides, you have only a mile and a half to go, and you have boots, raincoat and rain hat. And it's not a very cold rain, so why not?

Lucky you have a job in demolition too. It's steady work. Slow and dirty, but steady. The fading structures of a decaying city are the great mineral mines and hardware shops of the nation. Break them down and re-use the parts. Coal is too difficult to dig up and transport to give us energy in the amounts we need, nuclear fission is judged to be too dangerous, the technical breakthrough toward nuclear fusion that we hoped for never took place, and solar batteries are too expensive to maintain on the earth's surface in sufficient quantity.

Anyone older than 10 can remember automobiles. They dwindled. At first, the price of gasoline climbed—way up. Finally only the well-to-do drove, and that was too clear an indication that they were filthy rich, so any automobile that dared show itself on a city street was overturned and burned. Rationing was introduced to "equalize sacrifice," but every three months the ration was reduced. The cars just vanished and became part of the metal resource.

There are many advantages, if you want to look for them. Our 1997 newspapers continually point them out. The air is cleaner and there seem to be fewer colds. Against most predictions, the crime rate has dropped. With the police car too expensive (and too easy a target), policemen are back on their beats. More important, the streets are full. Legs are king in the cities of 1997, and people walk everywhere far into the night. Even the parks are full, and there is mutual protection in crowds.

If the weather isn't too cold, people sit out front. If it is hot, the open air is the only air conditioning they get. And at least the street lights still burn. Indoors, electricity is scarce, and

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few people can afford to keep lights burning after supper.

As for the winter—well, it is inconvenient to be cold, with most of what furnace fuel is allowed hoarded for the dawn; but sweaters are popular indoor wear and showers are not an everyday luxury. Lukewarm sponge baths will do, and if the air is not always very fragrant in the human vicinity, the automobile fumes are gone.

There is some consolation in the city that it is worse in the suburbs. The suburbs were born with the auto, lived with the auto, and are dying with the auto. One way out for the suburbanites is to form associations that assign turns to the procurement and distribution of food. Pushcarts creak from house to house along the posh suburban roads, and every bad snowstorm is a disaster. It isn't easy to hoard enough food to last till the roads are open. There is not much in the way of refrigeration except for the snowbanks, and then the dogs must be fought off.

What energy is left cannot be directed into personal comfort. The nation must survive until new energy sources are found, so it is the railroads and subways that are receiving major attention. The railroads must move the coal that is the immediate hope, and the subways can best move the people.

And then, of course, energy must be conserved for agriculture. The great car factories make trucks and farm machinery almost exclusively. We can huddle together when there is a lack of warmth, fan ourselves should there be no cooling breezes, sleep or make love at such times as there is a lack of light—but nothing will for long ameliorate a lack of food. The American population isn't going up much any more, but the food supply must be kept high even though the prices and difficulty of distribution force each American to eat less. Food is needed for export so that we can pay for some trickle of oil and for other resources.

The rest of the world, of course, is not as lucky as we are. Some cynics say that it is the knowledge of this that helps keep America from despair. They're starving out there, because earth's population has continued to go up. The population on earth is 5.5 billion, and outside the United States and Europe, not more than one in five has enough to eat at any given time.

All the statistics point to a rapidly declining rate of population increase, but that is coming about chiefly through a high infant mortality; the first and most helpless victims of starvation are babies, after their mothers have gone dry. A strong current of American opinion, as reflected in the newspapers (some of which still produce their daily eight pages of bad news), holds that it is just as well. It serves to reduce the population, doesn't it?

Others point out that it's more than just starvation. There are those who manage to survive on barely enough to keep the body working, and that proves to be not enough for the brain. It is estimated that there are now nearly 2 billion people in the world who are alive but who are permanently brain-damaged by undernutrition, and the number is growing year by year. It has already occurred to some that it would be "realistic" to wipe them out quietly and rid the earth of an encumbering menace. The American newspapers of 1997 do not report that this is actually being done anywhere, but some travelers bring back horror tales.

At least the armies are gone—no one can afford to keep those expensive, energy-gobbling monstrosities. Some soldiers in uniform and with rifles are present in almost every still functioning nation, but only the United States and the Soviet Union can maintain a few tanks, planes and ships—which they dare not move for fear of biting into limited fuel reserves.

Energy continues to decline, and machines must be replaced by human muscle and beasts of burden. People are working longer hours and there is less leisure; but then, with electric lighting restricted, television for only three hours a night, movies three evenings a week, new books few and printed in small editions, what is there to do with leisure? Work, sleep and eating are the great trinity of 1997, and only the first two are guaranteed.

Where will it end? It must end in a return to the days before 1800, to the days before fossil fuels powered a vast machine industry and technology. It must end in subsistence farming and in a world population reduced by starvation, disease, and violence to less than a billion.

And what can we do to prevent all this now?

Now? Almost nothing.

If we had started 20 years ago, that might have been another matter. If we had only started 50 years ago, it would have been easy.

yward from a geothermal well on the Island of Hawaii. The well is the hottest in the United States (357° C) ge quantities of dangerous dissolved solids and gases.

FUTURE ENERGY THE PROMISE AND THE PROBLEMS

By Elizabeth Dowling

Oil and natural gas have been primary sources of fuel for modern industrial nations. These sources were convenient to use, versatile, and—until now—cheap.

But recently, industrial nations such as the United States have been turning their attention to alternative sources of energy. Oil and natural gas may soon present greater problems than they're worth. For one thing, no one can say how long the supply of these fuels will last. It's almost certain, however, that they eventually will run out.

Many people also are alarmed at the environmental damage oil and natural gas production can wreak. Oil that leaks from offshore drilling sites, or spills from damaged supertankers, can blacken and foul water and beaches, wiping out whole communities of animals and plants.

Another problem is the United States' inability to produce enough oil and natural gas to meet its needs. If we continue to depend on oil and natural gas as energy sources, we will have to depend increasingly on the oil-producing countries of the Middle East. That means we will have little or no control over oil prices. And when Arabs hiked oil prices in 1973, the United States got a taste of how bitter that loss of control can be.

The chart below lists benefits and drawbacks of major alternative forms of energy.

TABLE 1. Advantages and Disadvantages of Different Energy Sources

Energy Source	Advantage	Disadvantage
COAL	Abundant source; technology developed	Mining coal harms environment, run-off may pollute water; deep mining dangerous for workers; restoring strip-mined land is slow, costly, not always successful; burning high-sulfur coal pollutes air

TABLE 1. Advantages and Disadvantages of Different Energy Sources (cont'd)

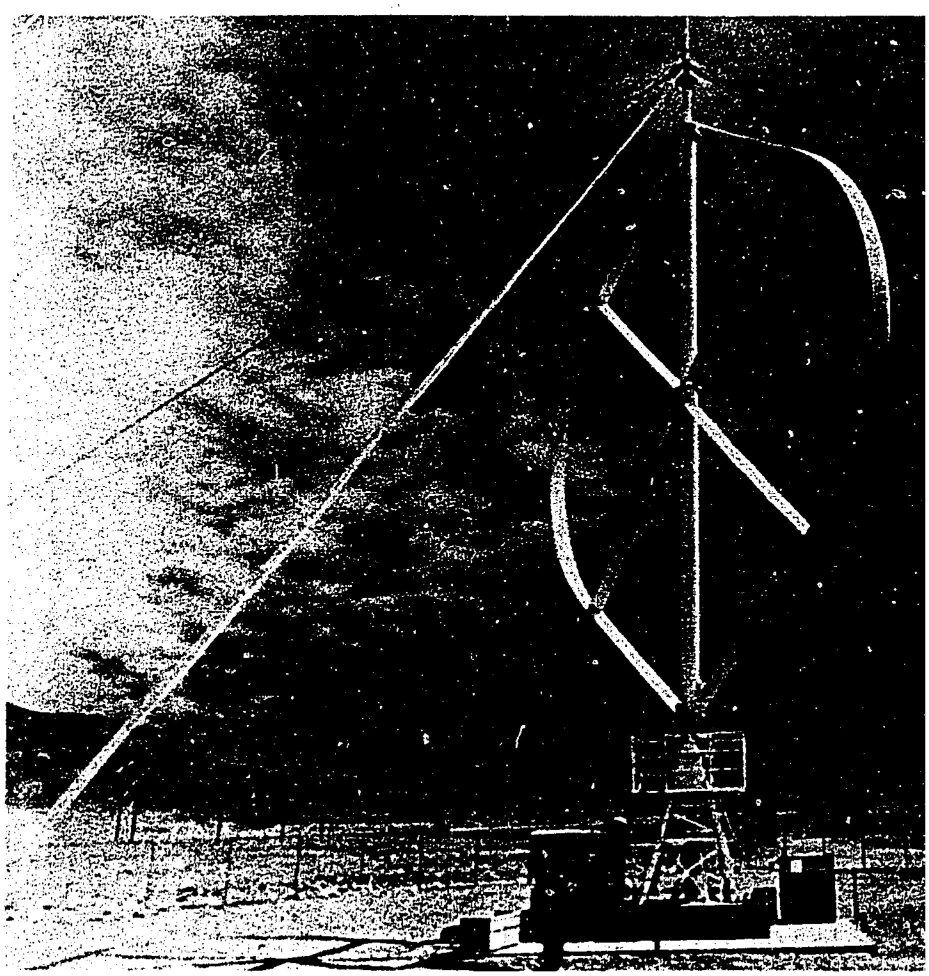
Energy Source	Advantage	Disadvantage
NUCLEAR FISSION	Produces power more cheaply than coal plants; abundant supply of uranium, which fuels nuclear reactors	Nuclear radiation, if leaked, may be fatal; problem of how to dispose of radioactive wastes; nuclear plants are expensive and time-consuming to build
NUCLEAR BREEDER REACTOR	"Breeds" more fuel as it burns fuel, so fuel is theoretically inexhaustible	Technology not commercially available before 1990; same (or more) radiation and waste-disposal problems as nuclear fission; since nuclear weapons can be made from its fuel, poses danger if sabotaged by terrorists
FUSION	Yields tremendous amount of energy as two atoms are forced to combine; byproducts have very low radioactivity, so fewer problems than other nuclear sources with radiation and waste disposal; unlimited fuel source	Hard to control fusion process; technology won't be available before year 1000, if then

TABLE 1. Advantages and Disadvantages of Different Energy Sources (cont'd)

Energy Source	Advantage	Disadvantage
SOLAR-THERMAL	Sun is an unlimited energy source, creates no harmful radiation or pollution; large areas of Earth get enough sunlight to use solar energy directly for buildings and power; technology now developed on small scale	Low-cost technology not widely available before 1990; costly and inconvenient to convert buildings; solar energy difficult to store and transmit; would need backup energy system if solar storage depleted; not a dependable source in cloudy or cold climates.
GEOTHERMAL	Untapped and extensive energy source; power plants take less time to build than coal or nuclear plants; technology already developed in individual cases on small scale	Technology not commercially available before 1980; "hot spots" of steam must be near Earth's surface to avoid need for complex plumbing; steam or hot water might contain polluting minerals which would create disposal problems; Earth's surface might cave in if underground pressure is reduced

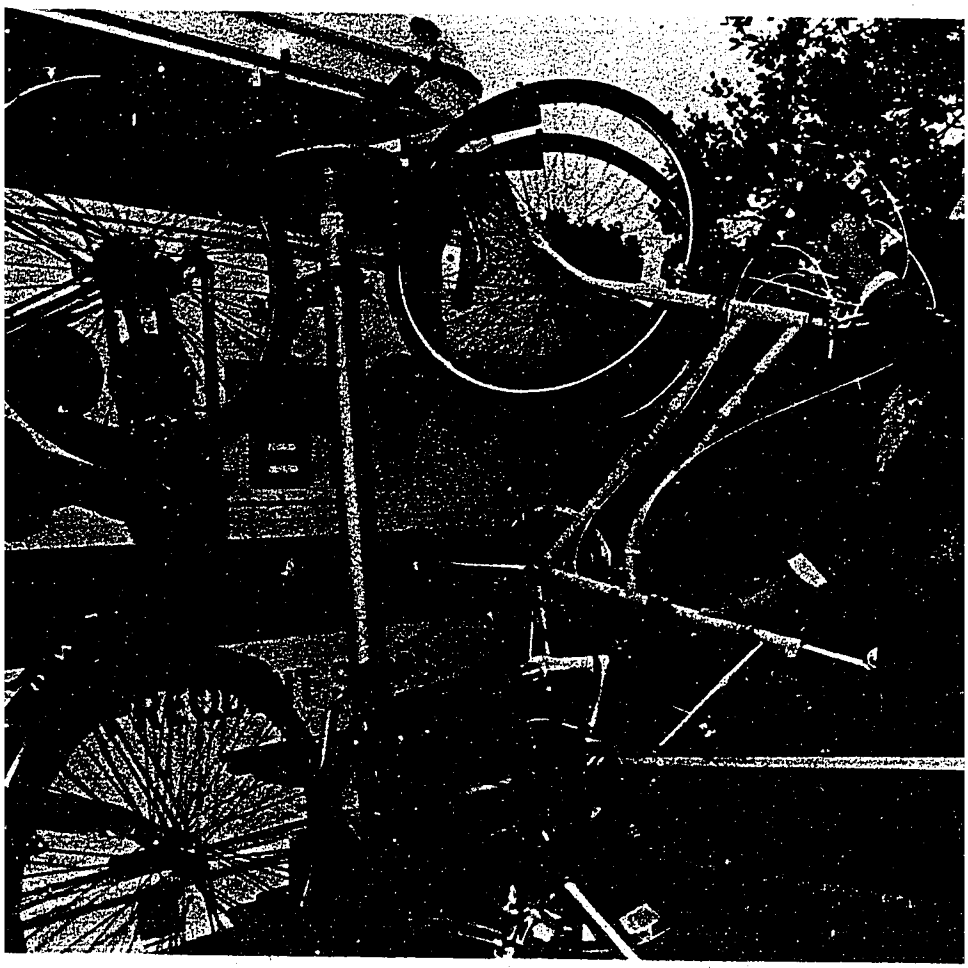
TABLE 1. Advantages and Disadvantages of Different Energy Sources (con't)

Energy Source	Advantage	Disadvantage
FUEL CELL	Little pollution because it uses fuel but doesn't burn it; wastes very little heat or gas	Technology not commercially available before 1985 or later
TIDAL	Effective in areas of steep tides; some pilot projects in operation	Not effective in areas of low tides or no tides
WIND	Technology developed on individual basis; could supply 5–10 percent of U.S. electricity needs by 2000	Technology still under development; difficult and currently too costly to store and transmit; energy source—wind—is erratic



This experimental wind turbine is seven stories high. It's rotor, which is 17 up to 70 kilowatts of power.

wide, is capable of producing



IT'S UP TO US

By Elaine Israel

What will happen to us? Will we push the search for new energy sources at the expense of our environment? Or will we give up the search and think only of preserving our environment?

We are at the crossroads.

One road leads to fast ways of finding energy sources. If we follow this road, we will allow the burning of high-sulfur coal. We will permit strip mining. We will encourage offshore oil drilling. We will do all this without thought to an ugly, polluted environment.

A second road turns down most new ways of finding energy. So we will have clean air. We will have untouched land. We will have oceans without oil slicks. But we won't have sources of energy.

There must be another road—one which leads to much-needed energy sources without destroying our land. Scientists and others who have studied the choices say it is possible to take this third road. What is needed is research, they say. Ways can be found to go on with the search and still preserve our fragile environment. This will cost millions of dollars, however. American taxpayers will have to pay the bill. Will they be willing to do it? Would you?

What can you do right now?

Twelve-year-old Elizabeth Lewison of Miami, Florida, is doing what she can. "If my mother leaves the television on when no one is watching it, I remind her to turn it off," she says. "When my father leaves lights on needlessly, I ask him to turn them off."

Little things do add up. If all three million customers of Consolidated Edison, a New York utility company, each turned off just one 100-watt bulb, ten days' supply of oil would be saved.

A Cleveland, Ohio, family carried out an experiment. They lived without any electricity for one day. Mr. and Mrs. James Marshall and their daughter Nancy discovered how few appliances are really necessary. They didn't miss using their electric can opener or their electric coffee pot or even their electric toothbrushes.

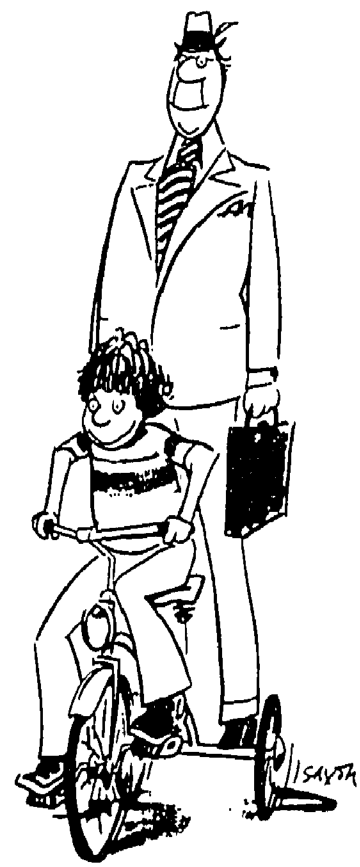
We can all change our living habits. Car owners have learned that big cars are wasteful. Small cars use less fuel. Those who need cars to get to work could join their neighbors in car pools. And, instead of hopping into the car all the time, we can learn to ride bicycles—or get used to walking.

Architects can design buildings that do not waste electricity. The glass skyscrapers now being built in cities from Los Angeles to New York must be heated or cooled constantly. And, in many of the buildings, lights must often be left on around the clock because they are part of the design.

Drivers: Save gasoline. Join a car pool. That's the message on these decals given out by an oil company.

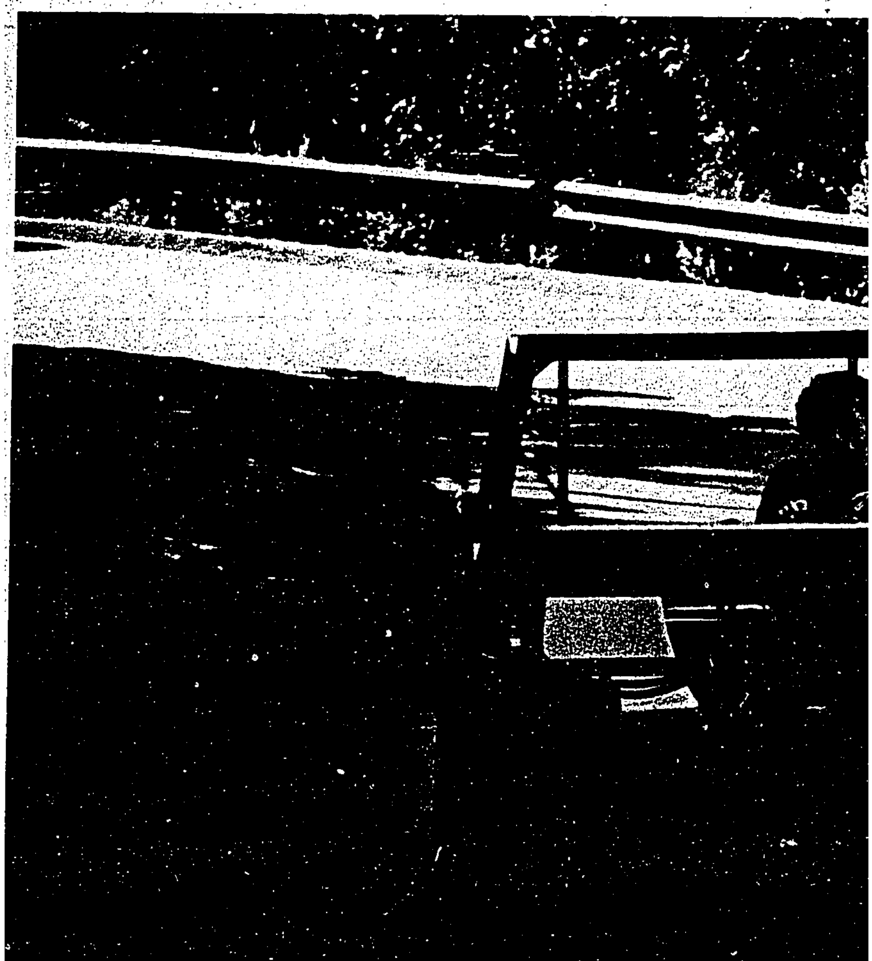
Figure 1. Decal Encouraging Drivers to Carpool

The shortage of energy sources may have improved our way of living in some ways. Fewer cars on city streets mean less air and noise pollution. Reduced driving speeds not only save gasoline, but they also cut down on accidents and save lives. Lower home and office thermostats mean cooler, healthier air. And rising gasoline prices may convince the government that more public transportation is needed.



The energy crisis has forced us to take a hard look at our living habits. We realize now that riding a bicycle or walking helps make some energy sources last longer.

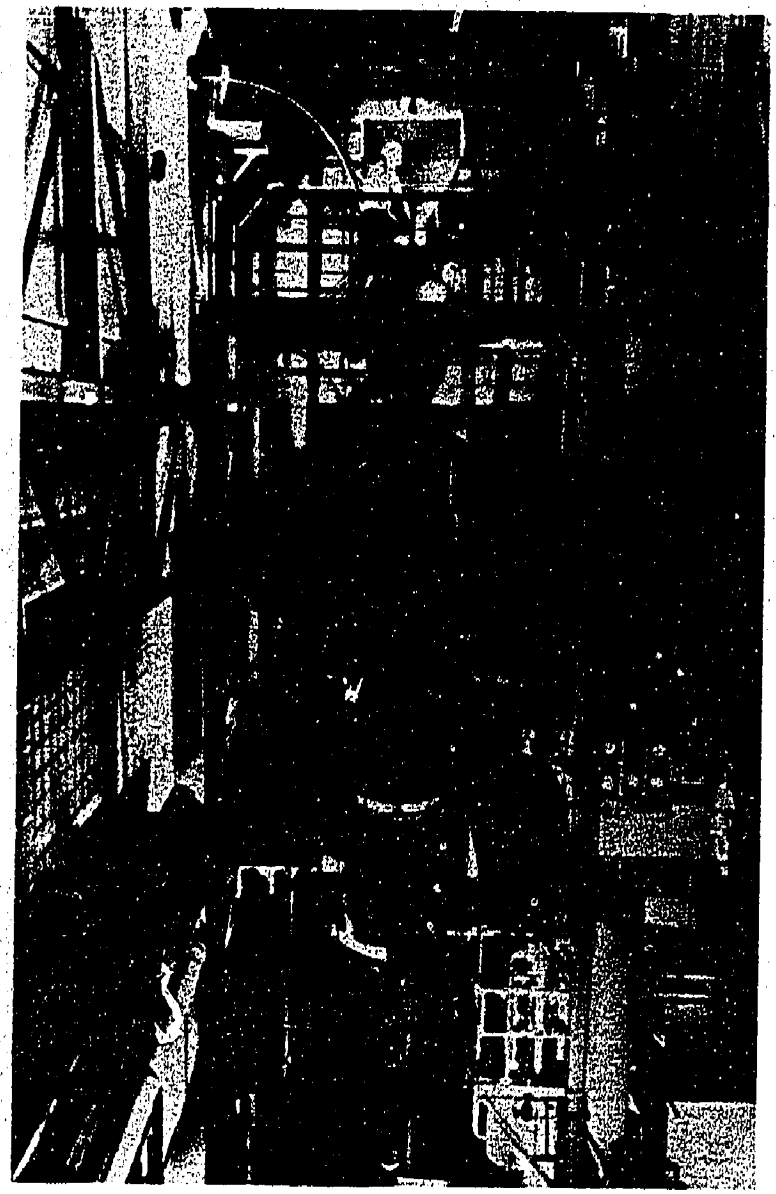
The energy crisis will be with us for a long time. But we can make use of it by deciding what things are really important. In the Chinese language, the character for "crisis" has two parts. One means "danger" and the other means "opportunity." This crisis may be our opportunity for a better future.



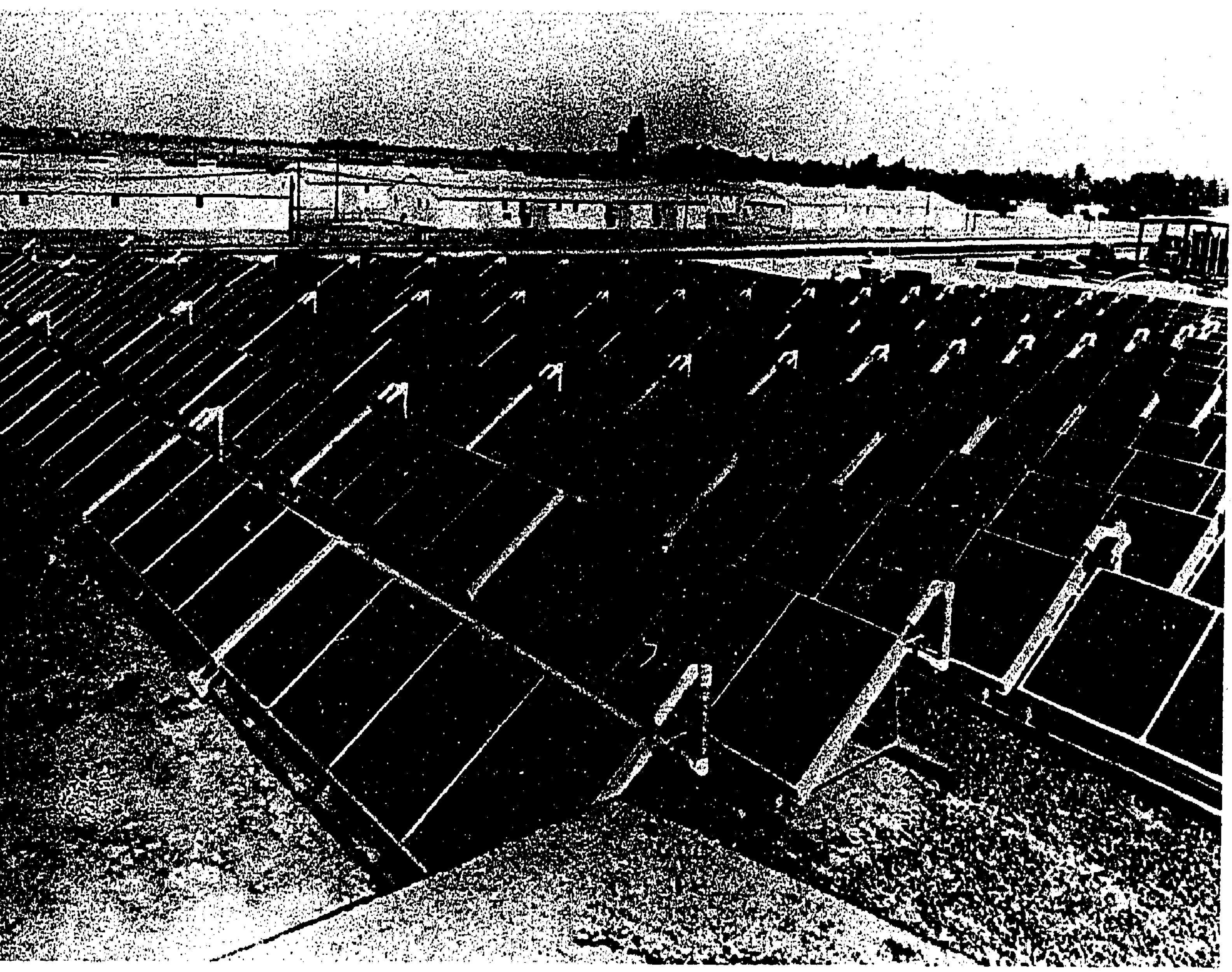
Power for this experimental electric vehicle is transferred inductively t
physical contact between the roadway and the vehicle.

ough a magnetic coupling device to eliminate

CHECK YOUR ENERGY VOCABULARY



John M. Fowler and King C. Kryger



A GLOSSARY OF TERMS

amperage—A measure of the volume of flow of an electrical current.

anthracite—"Hard coal," low in volatile matter, high in carbon content, with a heat value of 6.40 million Calories/ton.

atom—Consists of a heavy center or nucleus, made up of protons and neutrons, around which revolve blurs of energy called electrons.

atomic number of an atom—The number of protons in the nucleus.

atomic oven—Another name for atomic furnace. Sometimes called a uranium pile or a nuclear reactor.

atomic pile—A nuclear reactor, arranged to get energy out of the nuclei of atoms. The energy appears as heat.

barrel (bbl)—A liquid measure of oil, usually crude oil, equal to 42 gallons or about 306 pounds.

base load—The minimum load of a utility (electric or gas) over a given period of time.

bioconversion—A general term describing the conversion of one form of energy into another by plants or microorganisms. It usually refers to the conversion of solar energy by photo-synthesis.

biomass—Plant materials in any form from algae to wood.

bituminous coal—Soft coal; coal that is high in carbonaceous and volatile matter. It is "younger" and of lower heat value than anthracite or "hard coal." Heat value, 5.92 million Calories/ton.

black lung—A respiratory ailment, similar to emphysema, which is caused by inhalation of coal dust. Identified as a contributing cause in the deaths of many underground coal miners.

bottoming cycle—A means of using the low-temperature heat energy exhausted from a heat engine, a steam turbine, for instance, to increase the overall efficiency. It usually employs a low-boiling point liquid as working fluid.

breeder reactor—A nuclear reactor so designed that it produces more fuel than it uses. Uranium 238 (92 U^{238}) or thorium 232 (90 Th^{238}) can be converted to the fissile fuel, plutonium 239 (94 Pu^{239}) or uranium 233 (92

[1] Editor's Note: This material was produced in part by the National Science Teachers Association under contract with the U.S. Energy Research and Development Administration, now a component of the Department of Energy. The facts, statistics, projections, and conclusions are those of the authors.

U^{233}), by the neutrons produced within the breeder reactor core.

British Thermal Unit (Btu)—A unit of energy commonly used to measure heat energy or chemical energy. The heat required to raise the temperature of one pound of water 1°F, it is usually written Btu, and is equal to 778 foot-pounds of work or energy.

Calorie—The amount of heat required to raise the temperature of one gram of water one degree celsius.

capacity factor—A measure of the ratio of the electrical energy actually produced at a generating plant to the maximum design capacity of the plant.

capital intensive—Requiring heavy capital investment. The energy industry, for example, is said to be capital intensive rather than labor intensive because it employs relatively more dollars than people.

carbon dioxide (CO_2)—A compound of carbon and oxygen formed whenever carbon is completely burned (oxidized).

carbon monoxide (CO)—A compound of carbon and oxygen produced by the incomplete combustion of carbon. It is emitted by automobiles and is, as far as total weight is concerned, the major air pollutant.

carcinogen—A substance or agent producing or inciting cancerous growth.

catalyst—A substance which changes the speed of a chemical reaction without itself being changed.

catalytic converter—A device added to the exhaust system of an automobile that converts the air pollutants carbon monoxide (CO) and hydrocarbons (HC) to carbon dioxide (CO_2) and water. A similar conversion also removes nitrogen oxides (NO_x).

Celsius—The metric temperature scale in which the temperature of melting ice is set at 0°, the temperature of boiling water at 100°. One degree Celsius is 9/5 of a degree Fahrenheit. The Celsius scale is also known as the Centigrade scale.

Centigrade—See Celsius.

chain reaction—A reaction that stimulates its own repetition. In a fission chain reaction a fissionable nucleus absorbs a neutron and splits in two, releasing additional neutrons. These in turn can be absorbed by other fissionable nuclei, releasing still more neutrons and maintaining the reaction.

char—A porous, solid, nearly pure carbon residue resulting from the incomplete combusion of organic material. If produced from coal, it is

called coke; if produced from wood or bone, it is called charcoal.

chemical energy—A kind of energy stored inside the molecules of matter, which may be released or absorbed as their atoms are rearranged.

coal gasification—The conversion of coal to a gas suitable for use as a fuel.

coal liquefaction—The conversion of coal into liquid hydrocarbons and related compounds, usually by the addition of hydrogen.

coal tar—A gummy, black substance produced as a by-product when coal is distilled.

coke—Degassed coal (see char).

commutator—A set of electrical contacts that can convey electrical current between stationary and rotating devices.

conduction—(of heat) The transmission of energy directly from molecule to molecule.

confinement time—(in fusion) The time during which the reacting materials (deuterium and tritium, for instance) are physically confined at proper density to react.

convection—(of heat) The transfer of energy by moving masses of matter, such as the circulation of a liquid or gas.

converting energy—Changing energy from one form to another.

cooling towers—Devices for the cooling of water used in power plants. There are two types: wet towers, in which the warm water is allowed to run over a lattice at the base of a tower and is cooled by evaporation; and dry towers, in which the water runs through a system of cooling fans and is not in contact with the air.

critical mass—The smallest mass of fissionable material that will support a self-sustaining chain reaction under stated conditions.

crude oil—A mixture of hydrocarbons in liquid form found in natural underground petroleum reservoirs. It has a heat content of 1.46 million Calories/barrel and is the raw material from which most refined petroleum products are made.

current—The flow of electricity, comparable to the flow of a stream of water.

cyclotron—A machine for splitting atoms on a small scale and under controlled conditions, so that the process can be studied.

declining block rate—A method of charging for electricity wherein a certain number of kilowatt hours (the first block) is sold at a relatively high rate and succeeding blocks are sold

at lower and lower rates. Thus the charge for energy decreases as the amount consumed increases. (See "inverted block rate.")

deuterium—A non-radioactive isotope of hydrogen whose nucleus contains one neutron and one proton and is therefore about twice as heavy as the nucleus of normal hydrogen, which consists of a single proton. Deuterium is often referred to as "heavy hydrogen"; it occurs in nature as 1 atom to 6500 atoms of normal hydrogen.

efficiency of conversion—The amount of actual energy derived, by any technique in relation to the total quantity of energy existing in any source being tapped; expressed as a percentage.

elastic energy—The energy involved in the change of a piece of matter from its original shape which tends to restore this shape—as when a spring is stretched or a ball is compressed.

electrical energy—A kind of energy that arises because of electrical forces between particles of matters such as electrons.

electrolysis—The decomposition of a substance by means of an electric current as in the production of hydrogen and oxygen from water.

electron—An elementary particle with a negative charge that orbits the nucleus of an atom. Its mass at rest is approximately 9×10^{-31} kg, and it composes only a tiny fraction of the mass of an atom. Chemical reactions consist of the transfer and rearrangement of electrons between atoms.

electrostatic precipitator—A device that removes the bulk of particulate matter from the exhaust of power plants. Particles are attracted to electrically charged plates and the accumulation can then be washed away.

energy—A quantity having the dimensions of a forces times a distance. It is conserved in all interactions within a closed system. It exists in many forms and can be converted from one form to another. Common units are Calories, joules, BTUs, and kilowatt-hours.

energy intensiveness (EI)—A measure of energy utilization per unit of output. For passenger transport, for example, it is a measure of Calories used per passenger mile.

enrichment—A process whereby the percentage of a given isotope present in a material is artificially increased, so that it is higher than the percentage of that isotope naturally found in the material. Enriched uranium contains more of the fissionable isotope uranium 235 than the naturally occurring percentage (0.7%).

exothermic reaction—A reaction which releases more energy than is required to start it. The combustion reaction (burning) is an example as are fission and fusion reactions.

external combustion engines—An engine in which the fuel is burned outside the cylinders.

Fahrenheit—A temperature scale in which the temperature of melting ice is set at 32° and the temperature of boiling water at 212°. One Fahrenheit degree is equal to five-ninths of a Celsius degree.

fertile nucleus (or "fertile materials")—A material, not itself fissionable by thermal neutrons, which can be converted into a fissile material by irradiation in a reactor. There are two basic fertile materials, uranium 238 and thorium 232. When these fertile materials capture neutrons, they are converted into fissile plutonium 239 and uranium 233 respectively.

First Law of Thermodynamics—Also called the Law of Conservation of Energy. It states: Energy can neither be created nor destroyed.

fission—The splitting of atoms.

fluidized bed—A furnace design in which the fuel is buoyed up by air and some other gas. It offers advantages in the removal of sulfur during combustion.

fossil fuels—Fuels such as coal, crude oil, or natural gas, formed from the fossil remains of organic materials.

fuel cell—A device for combining fuel and oxygen in an electrochemical reaction to generate electricity. Chemical energy is converted directly into electrical energy without combustion.

fuel reprocessing—A recycling operation. Fissionable uranium and plutonium are recovered from uranium fuel rods which have undergone intense neutron bombardment in a nuclear reactor and fission products are removed.

fusion—The formation of a heavier nucleus by combining two lighter ones. In the reaction under study as a source of energy hydrogen (or helium 3) nuclei combine to form helium 4 with a subsequent release of energy.

gasoline—A petroleum product consisting primarily of light hydrocarbons. Some natural gasoline is present in crude oil but most gasoline is formed by "cracking" and refining crude oil. It has a heat value of 1.32 million Calories/barrel.

generating capacity—The capacity of a power plant to generate electricity. Usually measured in megawatts (Mw).

geopressured reservoir—Geothermal reservoir consisting of porous sands containing water or brine at high temperature or pressure.

geothermal energy—The heat energy in the Earth's crust whose source is the Earth's molten interior. When this energy occurs as steam, it can be used directly in steam turbines.

greenhouse effect—The warming effect of carbon dioxide, CO_2, and water vapor in the atmosphere. These molecules are transparent to incoming sunlight but absorb and reradiate the infrared (heat) radiation from the Earth.

half life—The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years.

heat—A form of kinetic energy that flows from one body to another because of a temperature difference between them. The effects of heat result from the motion of molecules. Heat usually measured in Calories or British Thermal Units (Btu's).

heat engine—Any device that converts thermal heat energy into mechanical energy.

heat pump—A device that transfers heat from a [illegible] region to a warmer one (or vise versa) by the expenditure of mechanical or electric energy. Heat pumps work on the same general principle as refrigerators and air conditioners.

heat value—The energy released by burning a given amount of the substance; also energy equivalent.

Helium 3 ($_2He^3$)—A rare, non-radioactive isotope of helium.

Helium 4 ($_2He^4$)—The common isotope of helium.

horsepower—A unit of power equal to 550 foot-pounds of work per second.

hot rock reservoir—A potential source of geothermal power. The "hot rock" system requires drilling deep enough to reach heated rock then fracturing it to create a reservoir into which water can be pumped.

hydrocarbons—Molecules composed of carbon and hydrogen atoms in various proportions. They are usually derived from living materials.

hydroelectric—Producing electrical power by the extraction of energy from the force of moving (usually falling) water.

hydroelectric plant—An electric power plant in which the energy of falling water is converted into electrical energy by a turbine generator.

hydrogenation—The addition of hydrogen to an organic molecule to increase the ratio of hydrogen to carbon, for instance in the production of oil from coal or from organic waste.

hydrothermal reservoir—One of the forms of geothermal reservoir systems. Consists of naturally circulating hot water or steam ("wet steam") or those which contain mostly vapor ("dry steam"). The latter type of hydrothermal reservoir is the most desirable type with present technology.

inertial confinement—One of two major techniques used in nuclear fission experimentation. (See "Magnetic Confinement".) A frozen pellet of deuterium and tritium is bombarded from all sides by an energy source—a laser beam of charged particles. The resulting *implosion* of the pellet results in high temperature and density which allows ignition of the fusion reaction and the pellet *explodes*.

internal combustion engine—An engine in which power is generated within one or more cylinders by the burning of a mixture of air and fuel, and converted into mechanical work by means of a piston. The automobile engine is a common example.

in situ—In the natural or original position or location. In situ conversion of oil shale, for instance, is an experimental technique in which a region of shale is drilled, fractured, and set on fire. The volatile gases burn off, the oil vaporizes, then condenses and collects at the bottom of the region, from which it can be recovered by a well. There also has been some experimentation with in situ conversion of coal.

inverted block rate—A method of selling electricity wherein a first "block" of kilowatt hours is offered at low cost and prices increase with increased consumption.

ionization—Removal of some or all electrons from an atom or molecule, leaving the atom or molecule with a positive charge, or the addition of one or more electrons, resulting in a negative charge.

ions—Atoms or molecules with electric charges caused by the addition or removal of electrons.

isotope—Any of two or more species of atoms having the same number of protons in the nucleus, of the same atomic number, but with differing numbers of neutrons. All isotopes of an element have identical chemical properties, but the different nuclear masses produce different physical properties. Since nuclear stability is governed by nuclear mass, one or more isotopes of the same element may be unstable (radioactive).

joule—A metric unit of work or energy; the energy produced by a force of one newton operating through a distance of one meter. One Btu=1055 joules, and one Calorie=4.185 joules.

kerosene—A petroleum distillate with a heat value of 1.43 million Calories/barrel presently used in gas turbines and jet engines.

kilocalorie—See Calorie.

kilowatt (kw)—A unit of power, usually used for electric power, equal to 1,000 watts, or to energy consumption at a rate of 1,000 joules per second.

kilowatt-hour (kw-hr)—A unit of work or energy. Equivalent to the expenditure of one kilowatt in one hour, about 853 Calories.

kinetic energy—The energy of motion. The ability of an object to do work because of its motion.

land subsidence—The sinking of a land surface as the result of the withdrawal of underground material. It results from underground mining and is a hazard of the development of geothermal fields.

langley—The amount of energy from solar radiation that, falling on an area of one square centimeter facing the sun on a clear day, [illegible]s one calorie of heat.

laser—A device for producing an intense beam of coherent, sharply focused, light. The name is an acronym for Light Amplification by Stimulated Emission of Radiation.

Law of Conservation of Energy—See First Law of Thermodynamics.

Lawson Criterion—A rough measure of success in fusion. For a self-sustaining fusion reaction to take place, the product of the confinement time (in seconds), and the particle density (in particles per cm^3) must be about 10^{14}.

life cycle costs—The total cost of an item including initial purchase price as well as cost of operation, maintenance, etc. over the life of the item.

lithium—The lightest metal; a silver-white alkali metal. Lithium 6 is of interest as a source of tritium for the generation of energy from a controlled fusion reaction. Molten lithium will also be the heat exchanger.

liquified natural gas (LNG)—Natural gas that has been cooled to approximately $-160°C$, a temperature at which it is liquid. Since liquefaction greatly reduces the volume of the gas, the costs of storage and shipment are reduced.

load factors—The percentage of capacity actually utilized. For example, the average number of passengers for a certain size car divided by the passenger capacity of that size car.

magnetic confinement—A confinement technique used in nuclear fusion in which electrons are stripped from the reacting nuclei (deuterium and tritium, for example) forming a "plasma" which can be controlled by a magnetic field. There are several different types of magnetic confinement systems under development. (See "Tokamak," "magnetic mirror," and "magnetic pinch device.")

magnetic energy—A kind of energy that arises when electrons or other charged particles move.

magnetic mirror—(See above) Consists of linear tubes in which the magnetic field confining a "plasma" is shaped so as to turn particles around at each end, as a mirror does a light beam. The most successful of these devices is the 2X-IIB at the Lawrence Livermore Laboratory of the University of California.

magnetic pinch device— (See above)—An interior space is filled with plasma which is then "pinched," or compressed by a magnetic field. This is accomplished by increasing the strength of the field and forcing the plasma toward the center of a tube. The Scyllac at Los Alamos is the major pinch device.

magnetic storage—A futuristic concept in which energy can be stored in a magnetic field around a superconducting material.

magnetohydrodynamic (MHD) *generator*—An expansion in which electricity is generated from the combustion of fuels without going through an intermediary steam turbine. Hot, partially ionized gases move through a magnetic field, and are separated by charge, generating a current that is then collected by electrodes lining the expansion chambers.

mechanical energy—One form of energy. It is observable as the motion of an object.

megawatt (mw)—A unit of power. A megawatt equals 1,000 kilowatts, or 1 million watts.

Methane Gas (CH_4)—A light hydrocarbon; an inflammable natural gas with a heat value of 257 Calories/cubic feet. Forms explosive mixtures with air. It is the major part of marsh gas and natural gas but can be manufactured from crude petroleum or other organic materials. (See coal gasification.)

Mev.—One million (or 10^6) electron volts—a unit of energy. It is equivalent to 1.6×10^{-13} joules.

MHD generator—See magnetohydrodynamic generator.

mill—A tenth of a cent. The cost of electricity is often given in mills per kilowatt hour.

moderator—A material used in a nuclear reactor to slow the speed of neutrons and thus control

the rate of fission. Common moderators are graphite, water, deuterium, and beryllium.

molecule—Atoms combined to form the smallest natural unit of a substance. For example, the water molecule is composed of two atoms of hydrogen and one atom of oxygen.

neutron—An elementary particle which is present in all atomic nuclei except for the most common isotope of hydrogen. Its mass is approximately that of a proton, but it has no electric charge. Neutrons are released in fission and fusion reactions.

Nitrous Oxides (NOx)—Compounds formed whenever combustion occurs in air (in the presence of nitrogen). An air pollutant and component of "photochemical smog."

nuclear converter reactor—A reactor in which the major process is the conversion of fissionable fuel into energy as distinguished from a "breeder reactor" which produces more fuel than it uses. A converter reactor also "converts" some fertile material into fissionable fuel but produces less fissionable fuel than it consumes.

nuclear energy—The energy released during reactions of atomic nuclei.

nuclear reactor—A device in which a fission chain reaction can be initiated, maintained, and controlled.

nucleus—The extremely dense, positively charged core of an atom. It contains almost the entire mass of an atom, but fills only a tiny fraction of the atomic volume.

ocean thermal energy conversion (OTEC)—A process of generating electrical energy by harnessing the temperature differences between surface waters and ocean depths.

"off-peak" power—Power generated during a period of low demand.

oil shale—A sedimentary rock containing a solid organic material called kerogen. When oil shale is heated at high temperatures, the oil is driven out and can be recovered.

OPEC—The Organization of Petroleum Exporting Countries. An organization of countries in the Middle East, North Africa, and South America which aims at developing common oil-marketing policies.

particulates—The small soot and ash particles produced by combustion.

peak demand period—That time of day when the demand for electricity from a powerplant is at its greatest.

peak load—The maximum amount of power delivered during a stated period of time.

peak load pricing—Charging more for the delivery of power during the daily period in which demand is the greatest. (See "peak demand period".)

petroleum—(or oil) an oily, flammable liquid that may vary from almost colorless to black and occurs in many places in the upper strata of the Earth. It is a complex mixture of hydrocarbons and is the raw material for many products.

photoelectric—Pertaining to electric effects produced by light.

photon—A quantum (the smallest unit) of electromagnetic radiation. It has no rest mass or electric charge, but behaves like both a particle and a wave in its interactions with other particles.

photosynthesis—The process by which green plants convert radiant energy (sunlight) into chemical potential energy.

Photovoltaic—Providing a source of electric current under the influence of light.

Photovoltaic generation—Direct and continuous generation of electrical energy by a material whenever it is illuminated by light; this is accomplished without breakdown of the material.

plasma—An electrically neutral, gaseous mixture of positive and negative ions. Sometimes called the "fourth state of matter," since it behaves differently from solids, liquids and gases. High temperature plasmas are used in controlled fusion experiments.

Plutonium (Pu)—A heavy, radioactive, man-made, metallic element with atomic number 94. Its most important isotope is fissionable plutonium 239 (94Pu^{239}), produced by neutron irradiation of uranium 238. It is used for reactor fuel and in weapons.

potential energy—"Stored" energy. Energy in any form not associated with motion such as that stored in chemical or nuclear bonds, or energy associated with the relative position of one body to another.

power—The rate at which work is done or energy expended. It is measured in units of energy per unit of time such as Calories per second, and in units such as watts and horsepower.

power gas—A mixture of carbon monoxide and hydrogen which has a low heat value (25–75 Calories/cubic feet) and is of most use as power plant fuel.

primary energy—Energy in its naturally occurring form—coal, oil, uranium, etc.—before conversion to end-use forms.

proton—An elementary particle present in all atomic nuclei. It has a positive electric charge. Its mass is approximately 1,840 times that of an electron. The nucleus of a hydrogen atom.

PSI—Abbreviation for "pounds per square inch." A measure of pressure.

pumped storage—An energy storage system in which reversible pump turbines are used to pump water uphill into a storage reservoir. The water can then be used to turn the turbines when it runs downhill.

Pyrolysis—Heating in the absence of oxygen. Also called "destructive distillation"; pyrolysis of coal produces three fuels: high BTU or pipeline gas, a synthetic crude oil (syncrude), and char, a carbon residue. Also used in the conversion of organic wastes to fuel.

radioactive decay—The spontaneous transformation of an atomic nucleus during which it changes from one nuclear species to another with the emission of particles and energy. Also called "radioactive disintegration."

reactor years—One year's operation of a nuclear reactor.

recoverable resource—That portion of a resource expected to be recovered by present-day techniques and under present economic conditions. Includes geologically expected but unconfirmed resources as well as identified reserves.

regenerative braking—Braking in which the energy is recovered either mechanically, in a flywheel for instance, or electrically. This energy can then be used in subsequent acceleration.

reserve—That portion of a resource that has been actually discovered but not yet exploited which is presently technically and economically extractable.

secondary recovery—Recovery techniques used after some of the oil and gas has been removed and the natural pressure within the reservoir has decreased.

Second Law of Thermodynamics—One of the two "limit laws" which govern the conversion of energy. Referred to sometimes as the "heat tax," it can be stated in several equivalent forms, all of which describe the inevitable passage of some energy from a useful to a less useful form in any cyclic energy conversion.

Second Law of Efficiency—The ratio of the minimum amount of work or energy necessary to accomplish a task to the actual amount used.

solar cells—Photovoltaic generators that yield electrical current when exposed to certain wavelengths of light.

solar energy—The electromagnetic radiation emitted by the sun. The Earth receives about 4,200 trillion kilowatt-hours per day.

solvent refined coal (SRC)—A tar-like fuel produced from coal when it is crushed and mixed with a hydrocarbon solvent at high temperature and pressure. It is higher in energy value and contains less sulfur or ash than coal.

Stirling engine—An external combustion engine in which air (or hydrogen in the newer versions) is alternately heated and cooled to drive the piston up and down. It is claimed to be non-polluting and more efficient than the internal combustion engine.

stratified charge engine—An engine in which the amount of charge, fuel plus air, is adjusted to engine conditions, directed to the area where it will burn best and fired at just the precise instant.

Strontium 90 ($38Sr^{90}$)—A hazardous isotope produced in the process of nuclear fission. Strontium 90 has a "half-life" of 28 years. Thus it takes 28 years to reduce this material to half its original amount, 56 years to one quarter, 84 years to one eighth, and so on. Strontium 90 typifies problems of radioactive waste storage which are faced in producing power by means of nuclear fission.

sulfur smog (classical smog)—This smog is composed of smoke particles, sulfur oxides (SOx), and high humidity (fog). The sulfur oxide (SO_3) reacts with water to form sulfuric acid (h_2SO_4) droplets, the major cause of damage.

superconductor—A material which at very low temperatures, near absolute zero, has no electrical resistance and thus can carry large electrical currents without resistance losses.

synthetic natural gas (SNG)—A gaseous fuel manufactured from coal. It contains almost pure methane, CH_4, and can be produced by a number of coal gasification schemes. The basic chemical reactions are $C + H_2O + \text{heat} \longrightarrow CO + H_2$; $3CH_2 + CO \longrightarrow CH_4 + H_2O$.

tar sand—A sandy geologic deposit in which low grade, heavy oil is found. The oil binds the sand together.

tertiary recovery techniques—Use of heat and other methods to augment oil recovery (presumably occuring after secondary recovery).

thermal storage—A system which utilizes ceramic brick or other materials to store heat energy.

thermodynamics—The science and study of the relationship between heat and other forms of energy.

thermostat—A temperature-sensitive device which turns heating and cooling equipment on and off at set temperatures.

Thorium (Th)—A naturally radioactive element with atomic number 90, and as found in nature, an atomic weight of approximately 232. The fertile thorium 232 ($90Th^{232}$) isotope can be transmuted to fissionable uranium 233 ($_{92}U^{233}$) by neutron irradiation.

Tokamak—(toroidal magnetic chamber) The Russian adaptation of the toroidal or "doughnut" geometry. The plasma is confined in the central region of an evacuated doughnut-shaped vessel by a magnetic field provided by current-carrying windings around the outside. A separate set of windings produce a heating current in the plasma. American examples are the PLT (Princeton Large Torus) and the ORMAC (Oak Ridge Tokamak).

topping cycle—A means to use high-temperature heat energy that cannot be used in a conventional steam turbine. A gas turbine, for instance, might operate as a topping cycle on furnace gases of 2000°F and its exhaust could then heat steam for a turbine operating at 1000°F.

total energy system—A packaged energy system of high efficiency, utilizing gas fired turbines or engines which produce electrical energy and utilize exhaust heat in applications such as heating and cooling.

Tritium—A radioactive isotope of hydrogen with a half life of 12.5 years. The nucleus contains one proton and two neutrons. It may be used as a fuel in the early fusion reactors.

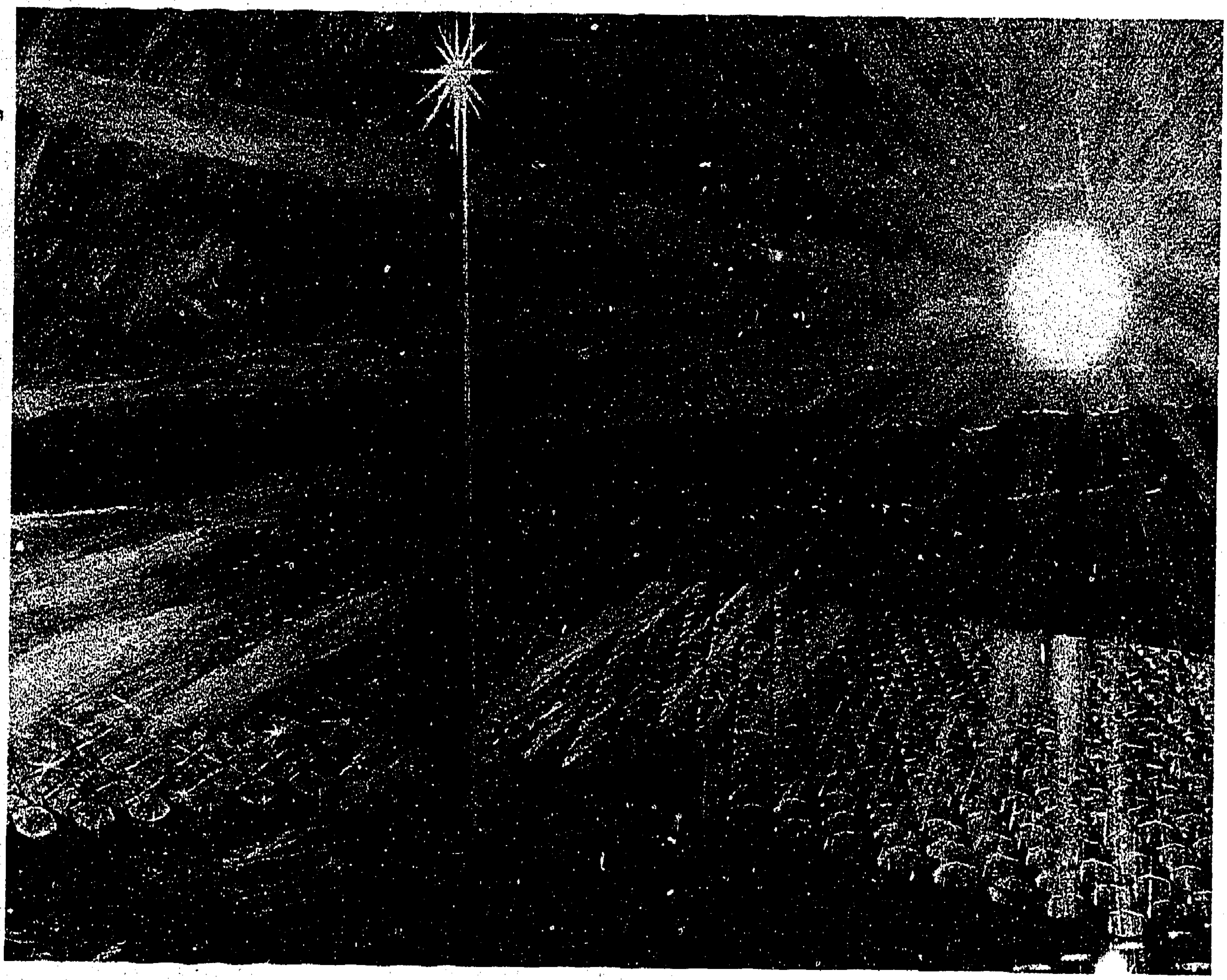
voltage—A measure of the force of an electric current.

watt (w)—A metric unit of power usually used in electric measurements which gives the rate at which work is done or energy expended. One watt equals one joule of work per second.

work—Energy that is transferred from one body to another in such a way that a difference in temperature is not directly involved. The product of an external force times the distance an object moves in the direction of the force.

working fluid—The material, usually a gas or a liquid, whose absorption of heat and subsequent expansion drives a heat engine. Steam is the "working fluid" of a steam engine.

yellowcake—The material which results from the first processing (milling) of uranium ore. It is sometimes called "artifiicial carnotite" and is about 53% uranium, a mixture of UO_2 and UO_3



An artist's concept of a 10-megawatt solar thermal pilot plant.

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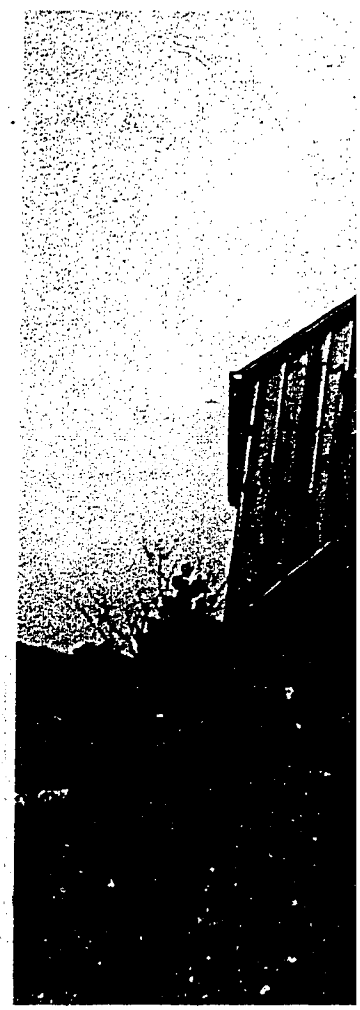

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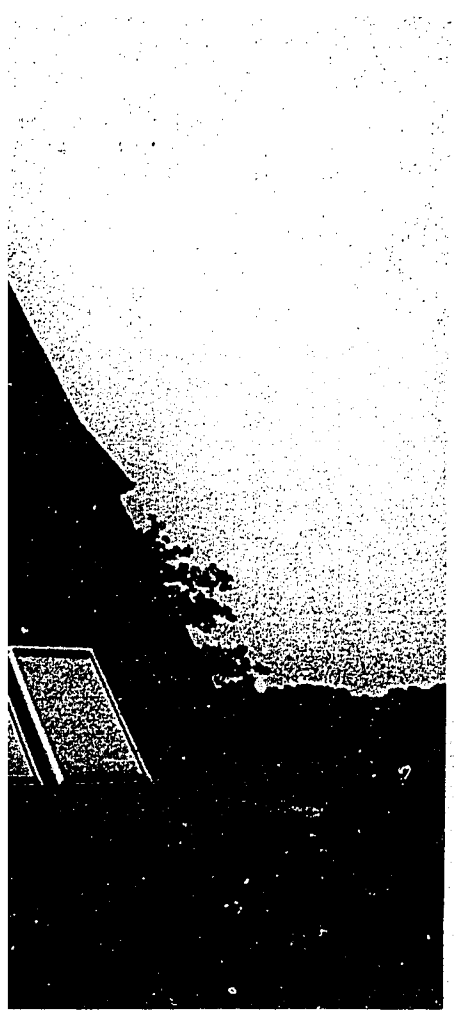

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